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AUTHOR Auzmendi, Elena
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ABSTRACT

A multifactorial scale of attitudes toward statistics was developed, and factors related to attitudes toward statistics (objective and subjective mathematics background, anxiety, spatial ability, expectations, motivation, attitudes toward computers, teacher and course evaluation, sex and sex-role stereotypes, and major) were investigated for college students in Spain. Twenty-five items for assessing five different dimensions (motivation, enjoyment, anxiety, confidence, and usefulness) were incorporated into a multifactorial scale--the Multifactorial Scale of Attitudes toward Statistics (MSAS). Then, two studies were conducted. In the first study, the MSAS was administered to 101 undergraduates. Coefficient alpha was between 0.60 and 0.87 for the different factors and the total scale. Evidence concerning the validity of the instrument came from its correlation (0.84) with another measure of attitudes toward statistics. The subjects for the second study were 2,052 students from various disciplines enrolled in introductory statistics courses at two universities in Spain in the 1989-90 academic year. During the pretest (at the beginning of the course) and during the posttest (at the end of the course), several instruments were administered to students to measure factors similar to those investigated in the first study that might have a bearing on attitude toward statistics. Regression analyses determined predictors of attitudes toward statistics. Predictive factors before the course included: expectations of success and failure; attitudes toward computers; objective and subjective background; motivation; and state anxiety. Predictive factors at the end of the course included: expectations of success and failure; subjective and objective background; level of the subject; and teacher and course evaluation. Eight tables present study findings. A 25-item list of references is included. (SLD)

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FACTORS RELATED TO ATTITUDES TOWARD STATISTICS

A Study with a Spanish Sample

Elena Auzmendi
Deusto University-Spain

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Abstract

This study had two purposes, to develop a multifactorial scale of attitudes toward statistics and to investigate factors related to attitudes toward statistics. The Multifactorial Scale of Attitudes toward Statistics was developed in several steps. Twenty five items for assessing five different dimensions (Motivation, Enjoyment, Anxiety, Confidence, and Usefulness) were incorporated into a scale. Coefficient alpha was between .60 and .87 for the different factors and the total scale. Evidence concerning the validity of the instrument comes from its correlation (.84) with another measure of attitudes toward statistics. The subjects for the second study were 2052 students enrolled in introductory statistics courses at The University of the Basque Country and Deusto University (Spain) during the 1989-1990 academic year. The subjects were undergraduate students from numerous disciplines in the university. During the pretest (at the beginning of the course) and during the postest (at the end of the course) several instruments were administered to the students to measure their mathematical background, spatial ability, motivation, expectations, sexual role, computer attitudes, anxiety, major, course and teacher evaluation, achievement and attitudes toward statistics. Regression analyses were performed to determine the predictors of attitudes toward statistics.

Statistics is being recognized as an important and useful branch of mathematics (Lappan & Zawojewski, 1988). Statistical methods have become requisite for a wide range of fields of study like biology, business, medicine, engineering, computer science, psychology, education, and so on (Blalock, 1966; Brancroft, 1966; Garfield & Ahlgren, 1988). As a consequence, increasing numbers of students with diverse backgrounds, interests, and goals are enrolling in statistics courses as a necessary part of their curriculum (Feinberg & Halperin, 1978). Many of them seem to show a marked adversion for the class. More than that, some students seem to fear, even hate, statistics.

Many statistics instructors have formulated assumptions about the reasons for this phenomenon, often on the basis of little empirical evidence (Harvey, Plake & Wise, 1988). Most of the studies have investigated the relationship between select learner characteristics and statistics achievement. However, few studies have focused on factors related to attitudes toward statistics.

The development of positive attitudes toward subjects is an important part of the educational process. Student's attitude toward mathematics would be important in determining whether he or she elects to take courses in mathematics, engage in mathematics activities and persevere in these efforts once he or she has begun (Aiken, 1972). It is important to improve the present level of statistics achievement. But it is more important to change the students' negative attitudes. If we manage to develop positive attitudes toward statistics in our students, they will use this subject in their present and future professional and daily lives.

On the basis of this assumption, the present study had two purposes:

1.To develop a multifactorial scale of attitudes toward statistics. The first problem in defining attitudes toward statistics is to decide if it is an uni or multidimensional construct. The oldest scales were developed to measure only one general dimension. However, during recent years, researchers have recognized that attitude is a multidimensional construct requiring more complex assessment procedures. Such multivariate scales, Fennema and Sherman (1976), Aiken (1979), Sandman (1980), have been designed to assess a combination of affective and cognitive dimensions of attitudes, for example, "anxiety" or "recognition of its importance". So it is important to develop instruments to assess the general construct as well as its different dimensions.

2. To investigate the contribution of several variables to general attitude toward statistics and to usefulness, enjoyment, confidence, motivation and anxiety toward statistics. These variables are the following:

a. **Objective and Subjective Mathematical Background**. Many students enrolled in applied statistics classes have expressed great concern about their success in the course due to their perceived inadecuate mathematical background (Elmore & Vasu, 1980). The number of previous mathematical courses and their perceived ability in those courses can influence the difficulties encountered by many of these students.

b. **Anxiety**. Attitudes are affective variables, so some relationship between a measure of attitude and a measure of anxiety toward a particular subject should not be unexpected. In addition, anxiety and attitude may be either general or specific, pertaining to only one situation or event, or to many (Aiken, 1970). It is important to differentiate between the role of general and specific anxiety in mathematics. So a negative correlation can be expected between measured situational anxiety and students' attitude toward statistics and no correlation between general anxiety and students' attitudes.

c. **Spatial Ability**. Since many of the concepts introduced in an inferential statistics course are visual, spatial ability should be correlated with statistical aptitude (Elmore & Vasu, 1980).

d. **Expectations**. Historical events, past experiences of success and failure, and cultural factor are proposed to have indirect effects that are mediated through the individual's interpretations of these past events, perceptions of the expectations of others, and identification with the goals and values of existing cultural role structures (Eccles, 1983). All these variables can influence students' attitudes toward statistics.

e. **Motivation**. Intrinsic motivation is a potentially central motivator of the educational process. However, there are significant portions of the academic curriculum that are not inherently interesting. So, many aspects require the use of extrinsic supports and structures. Recent reviews of motivation in education have increasingly recognized the importance of intrinsic and

extrinsic motivation in the promotion of students' learning (Deci & Ryan, 1985).

f. **Attitudes toward Computers**. The use of computers as instructional aides can produce highly significant effects on attitudes. However, anxiety toward this subject may influence the learning process. So it seems likely that students' attitudes toward computers may be an important factor in the success or failure of the new computer programs (Loyd & Gressard, 1984).

g. **Teacher and Course Evaluation**. Teachers' attitudes and effectiveness in mathematics are viewed as being prime determiners of students' attitudes and performance in the subject (Aiken, 1970).

h. **Sex and Sex-Role Stereotypes**. There is little research focused on sex-related differences in statistics attitudes and achievement. Elmore & Vasu (1980) found that female students had more positive attitudes than males on the Attitudes toward Success in Mathematics and on the Mathematics as a Male Domain subscales of the Fennema-Sherman Mathematics Attitude Scales. Also, female students received a significantly higher mean number of total points in the course than males. In the other hand, masculinity-femininity of interest pattern is considered one of the variables related to performance in statistics courses. Thus, Elmore & Vasu (1980) found that this variable contibutes significantly to the prediction of statistics achievement.

i. **Major**. This variable is very closely related to mathematical background. Many students enrolled in statistics courses have an inadequate mathematical background. This generally occurs in the humanatities majors such as psychology, education, sociology, and so on. These students have a lack of practice in this area and an inadequate mathematical training.

FIRST STUDY: DEVELOPMENT OF A MULTIFACTORIAL SCALE OF ATTITUDES TOWARD STATISTICS

The Multifactorial Scale of Attitudes toward Statistics was developed in several steps. Initially five possible dimensions of attitudes toward statistics were defined for assessment: Enjoyment, Anxiety, Motivation, Confidence, and Usefulness. The process of choosing these five dimensions consisted in analysing the factorial structure of several mathematics attitudes scales and selecting the most frequent dimensions.

Forty items were constructed or adapted from eight existing math attitudes scales, two science attitudes questionnaires and one computer inventory. A principal-components factor analysis with varimax rotation was done in a pilot study with 213 undergraduate students. After this study 25 items for assessing the five different dimensions (five per factor) were incorporated into a Likert-type scale with five ordered responses from strongly disagree to strongly agree. Table 1 represents the factor loadings for the 25 items.

Coefficient alpha was .80 for the Usefulness Factor (Factor I), .81 for the Anxiety Factor (Factor II), .84 for the Confidence Factor (Factor III), .83 for the Enjoyment Factor (Factor IV), .60 for the Motivation toward Its Study and Use Factor (Factor V), and .87 for the Total Scale.

Evidence concerning the validity of the instrument comes from data collected on a separate study conducted after the pilot one. One hundred and one psychology and education undergraduate students completed the scale and another test of attitudes toward statistics, the Attitudes toward Statistics Scale by Dennis M. Roberts. The Pearson product-moment correlation coefficient between subjects' scores on the two instruments was .86 indicating that both scales measure the same general construct.

	FACTORS				
ITEMS	I	II	III	IV	V
1.	.815				
6.	.788				
11.	.727				
20.	.687				
21.	.620				
2.		.803			
7.		.749			
12.		.731			
17.		.705			
22.		.676			
3.			.830		
8.			.774		
13.			.748		
18.			.690		
23.			.616		
4.				.802	
9.				.783	
14.				.763	
19.				.689	
24.				.594	
5.					.719
10.					.658
15.					.533
16.					.509
25.					.400

Table 1. Varimax Rotated Factor Loadings for the 25 Items.
Note. All items have been scored so that higher scores indicate more positive attitudes.

SECOND STUDY: FACTORS RELATED TO ATTITUDES TOWARD STATISTICS

Method

Subjects

The subjects for this study were 2052 students enrolled in introductory statistics courses at The University of the Basque Country and Deusto University (Spain) during the 1989-1990 academic year. The subjects were undergraduate students from numerous disciplines in the university such as psychology, education, computer science, business, sociology, medicine, engineering, mathematics, advertising, and biology. This study was conducted at the beginning of the course (pretest) and at the end (postest).

Instruments

The following instruments were administered:

1. Biographical Data Sheet. This included sex, major, previous mathematics-related coursework (number of years of high school mathematics, whether a statistics or probability course had been taken), subjective perception about previous mathematical ability, expectations of failure and success in the statistics course.

2. State-Trait Anxiety Inventory (Spielberger, Gorsuch & Lushene, 1970). The State-Trait Inventory is comprised of separate self-report scales for measuring two distinct anxiety concepts: state anxiety (A-State) and trait anxiety (A-Trait). The STAI A-Trait scale consists of 20 statements that ask people to describe how they generally feel. The A-State scale also consists of 20 statements, but the instructions require subjects to indicate how they feel at a particular moment in time.

3. Masculinity-Femininity Scale of the MMPI (Hathaway & Mckinley, 1967). This scale was scored, for each student, using both the female and male scoring keys.

4. Motivation Scale. This scale includes three Likert-type subscales: Intrinsic Motivation, Extrinsic Motivation and Motivation toward the Major. All these items use a 5-points rating scale from "strongly disagree" to "strongly agree" .

a. **Intrinsic Motivation**. This subscale includes five items. A low score reflects a low intrinsic motivation and a high score reflects the opposite.
b. **Extrinsic Motivation**. This subscale includes five items. A low score reflects a low extrinsic motivation and a high score reflects that students only study for the external reinforcement.
c. **Motivation toward the Major**. This subscale includes three items. A low score reflects that students dislike the subjects they are studying and a high score reflects the opposite.

5. Multifactorial Scale of Attitudes toward Statistics (Auzmendi, 1988). The scale includes 25 items, five per factor (Enjoyment, Anxiety, Motivation, Confidence, and Usefulness). A high score indicates a positive attitude toward statistics and a low score reflects a negative attitude toward statistics.

6. Computer Attitude Scale (Loyd & Gressard, 1984). It is a Likert-type instrument consisting, initially, of 30 items which present statements of attitudes toward computers and the use of computers. Three main types of attitudes are represented, Anxiety, Liking, and Confidence in ability to use or learn about computers. The current scale has forty items and another factor, Usefulness of computers.

7. Spatial Relations Test of the Differential Aptitude Test (Bennett, Seashore & Wesman, 1973). This test was used to measure spatial ability.

8. Course and Teacher Evaluation Scale (Villa, 1988). This is a Likert-type scale consisting of 31 items which present statements of six kinds of evaluation: a) competence, b) relationship with the students, c) ability to create interest in the class, d) feedback, e) evaluation, f) use of new references in the class. The scale has another five items for measuring students' attitudes toward the subject, motivation, interest, dedication, and another six items about course, number of students in the class, professor's requirement, whether the course is easy or difficult, and so on.

Procedure

This study was conducted during the 1989-1990 academic year. During the Pretest (at the beginning of the course, in October 1989) the students were administered the Biographical Data Sheet, the Space Relations Test of the Differential Aptitude Test, the State-Trait Anxiety Inventory, the Masculinity-Femininity Scale of the MMPI, the

Motivation Scale, the Multifactorial Scale of Attitudes toward Statistics, and the Computer Attitude Scale, during a testing session the first month of the course. During the Postest (at the end of the course, in May 1990) the same students answered the Space Relations Test of the DAT, the STAI, the Motivation Scale, the Multifactorial Scale of Attitudes toward Statistics, and the Course and Teacher Evaluation Scale. With the students' and their statistics instructors' permission, the students' course grades were obtained as a measure of their statistics achievement. The data were coded assigning numbers to the students and deleting the students' names as soon as the data were coded.

Research Questions

1. How much variance in statistics attitudes and in the different factors of attitude toward statistics, at the beginning of the course, can be accounted for by the different variables measured at that moment?

2. How much variance in statistics attitudes and in the different factors of attitude toward statistics, at the end of the course, can be accounted for by the different variables measured at that moment?

Data Analysis

The questions were answered using the multiple linear regression model. As there were many independent variables to predict the dependent variables, a procedure for selecting variables was chosen, stepwise regression. R^2 never decreases as independent variables are added. However, this doesn't necessarily mean that the equation with the most variables best fits the population. A model with many variables is often difficult to interpret. On the other hand, it's important not to exclude potentially relevant independent variables.

Results

In creating a relevant model for the regression analyses, all variables identified as being potentially important predictors of attitudes toward statistics were included. They were the following:

a. **Pretest**:

- Sex
- Spatial Ability
- Objective Background:
    * Number of years of high school mathematics
    * Whether a statistics or probability course had been taken before
    * Total Score
- Subjective Background (subjective perception about previous mathematical ability)
- Expectations:
    * Expectations of success or failure in the course
    * Expectations of grade
    * Expectations of sex (whether they think that the course will be more difficult for men or for women)
    * Total score
- Sex Role
- Anxiety:
    * State
    * Trait
- Motivation:
    * Intrinsic
    * Extrinsic
    * Toward the major
    * Total score
- Attitudes toward Computers:
    * Anxiety
    * Confidence
    * Enjoyment
    * Usefulness
    * Total score

b. Postest:

- Sex
- Spatial Ability
- Objective Background:
    * Number of years of high school mathematics
    * Whether a statistics or probability course had been taken before
    * Total Score
- Subjective Background (subjective perception about previous mathematical ability)
- Expectations:
    * Expectations of success or failure in the course
    * Expectations of grade
    *Expectations of sex (whether they think that the course will be more difficult for men or for women)
    * Total score
- Sex Role
- Anxiety:
    * State
    * Trait
- Motivation:
    * Intrinsic
    * Extrinsic
    * Toward the major
- Teacher and Course Evaluation:
    * Competence
    * Relationship with the students
    * Ability to create interest in the class
    * Feedback
    * Evaluation
    * Use of new references in the class
- Level of the Course
- Requirement of the Course
- Number of Students in the Class

Twelve different multiple regression analyses were calculated. Table 2 shows the amount of variance in the different dependent variables accounted for by the different independent variables sets.

Dependent Variables	R^2
Attitude toward Statistics (Pretest)	.3254
Anxiety (Pretest)	.3985
Confidence (Pretest)	.3840
Enjoyment (Pretest)	.2144
Motivation (Pretest)	.1065
Usefulness (Pretest)	.1123
Attitude toward Statistics (Postest)	.3701
Anxiety (Postest)	.4770
Confidence (Postest)	.3922
Enjoyment (Postest)	.2674
Motivation (Postest)	.2207
Usefulness (Postest)	.1560

Table 2. Summary of Amount of Variance in the Different Dependent Variables Accounted for by the Different Independent Variables Sets.

The amount of variance accounted for by the independent variables in the different dependent variables is very different. So these independent variables are very poor as predictors of the students' motivation toward statistics and their perception of the usefulness of this subject.

The amount of variance in **attitudes toward statistics at the beginning of the course** accounted for by the a) expectations of success in the course, b) attitudes toward computers, c) intrinsic motivation, d) subjective perception about previous mathematical ability, e) state anxiety, f) perception of the computer usefulness, g) whether a statistics or probability course had been taken before, h) motivation toward the major, i) number of years of high school mathematics, j) expectations of grade in the course, k) sex, was .32 (Table 3).

Variables	Multiple R	R^2	F	Signif.
Expectations of Success	.4578	.2095	397.102	.000
Attitudes toward Computers	.5253	.2760	285.306	.000
Intrinsic Motivation	.5364	.2877	201.443	.000
Subjective Background	.5475	.2998	160.006	.000
State Anxiety	.5546	.3076	132.722	.000
Computer Usefulness	.5599	.3134	113.597	.000
Previous Statistics Courses	.5639	.3179	99.361	.000
Motivation Toward the Major	.5655	.3198	87.635	.000
Previous Mathematics Courses	.5671	.3216	78.487	.000
Expectations of Grade	.5688	.3236	71.221	.000
Sex	.5704	.3254	65.236	.000

Table 3.Summary of Regression Analysis Using Attitudes toward Statistics, at the Beginning of the Course, as Dependent Variable.

The amount of variance in **attitudes toward statistics at the end of the course** accounted for by the a) total expectations in the course, b) teacher ability to create interest in the class, c) level of the subject, d) number of years of high school mathematics, e) evaluation, f) intrinsic motivation, g) use of new references in the class, h) teacher-students relationship, i) subjective perception of previous mathematical ability, j) teacher competence, was .37 (Table 4).

Variables	Multiple R	R^2	F	Signif.
Total Expectations	.3595	.1292	115.022	.000
Interest in the Class	.4518	.2042	99.283	.000
Level of the Subject	.5164	.2667	93.691	.000
Objective Background	.5446	.2966	81.376	.000
Evaluation	.5664	.3208	72.817	.000
Intrinsic Motivation	.5843	.3414	66.511	.000
Use of New References	.5921	.3506	59.307	.000
Teacher-Stud. Relationship	.5981	.3577	53.473	.000
Subjective Background	.6039	.3647	48.929	.000
Teacher Competence	.6084	.3701	45.016	.000

Table 4. Summary of Regression Analysis Using Attitudes toward Statistics, at the End of the Course, as Dependent Variable.

The amount of variance in **anxiety toward statistics at the beginning of the course** accounted for by the a) expectations of success in the course, b) subjective perception of previous mathematical ability, c) trait anxiety, d) anxiety about computers, e) number of years of high school mathematics, f) expectations of grade in the course, g) state anxiety, h) enjoyment of computers, i) confidence with the computers, j) motivation toward the major, was .40 (Table 5).

Variables	Multiple R	R^2	F	Signif.
Expectations of Success	.5224	.2729	562.200	.000
Subjective Background	.5705	.3254	361.097	.000
Trait Anxiety	.5981	.3578	277.810	.000
Anxiety about Computers	.6075	.3690	218.571	.000
Objective Background	.6146	.3777	181.366	.000
Expectations of Grade	.6203	.3848	155.617	.000
State Anxiety	.6248	.3904	136.500	.000
Enjoyment of Computers	.6273	.3935	120.901	.000
Confidencein Computers	.6294	.3961	108.589	.000
Motivat. toward the Major	.6312	.3985	98.632	.000

Table 5. Summary of Regression Analysis Using Anxiety toward Statistics, at the Beginning of the Course, as Dependent Variable.

The amount of variance in **anxiety toward statistics at the end of the course** accounted for by the a) expectations of success in the course, b) level of the subject, c) subjective perception of previous mathematical ability, d) evaluation, e) state anxiety, f) teacher competence, g) number of years of high school mathematics, h) feedback, i) total expectations in the course, j) number of students in the the class, was .48 (Table 6).

Variables	Multiple R	R^2	F	Signif.
Expectations of Success	.4675	.2186	216.792	.000
Level of the Subject	.5826	.3394	198.852	.000
Subjective Background	.6165	.3801	157.962	.000
Evaluation	.6482	.4202	139.850	.000
State Anxiety	.6690	.4476	124.922	.000
Teacher Competence	.6755	.4563	107.699	.000
Objective Background	.6817	.4647	95.360	.000
Feedback	.6854	.4697	85.046	.000
Total Expectations	.6887	.4736	86.382	.000
Number of Students	.6907	.4770	77.735	.000

Table 6.Summary of Regression Analysis Using Anxiety toward Statistics, at the End of the Course, as Dependent Variable.

The amount of variance in **confidence in one's own ability to work with statistics, at the beginning of the course**, accounted for by the a) total expectations of success, b) confidence in one's own ability to work with computers, c) state anxiety, d) subjective perception of previous mathematical ability, e) enjoyment of computers, f) total motivation, g) total objective background, h) trait anxiety, i) anxiety about computers, j) expectations of success in the course, k) extrinsic motivation, was .38 (Table 7).

Variables	Multiple R	R^2	F	Signif.
Total Expectations	.4916	.2417	477.354	.000
Confidencein Computers	.5490	.3014	322.976	.000
State Anxiety	.5791	.3354	251.668	.000
Subjective Background	.5938	.3526	203.534	.000
Enjoyment of Computers	.6000	.3600	168.058	.000
Total Motivation	.6052	.3663	143.830	.000
Total Objective Background	.6107	.3729	126.751	.000
Trait Anxiety	.6141	.3771	112.854	.000
Anxiety about Computers	.6167	.3803	101.590	.000
Expectations of Success	.6183	.3823	92.142	.000
Extrinsic Motivation	.6196	.3840	84.313	.000

Table 7. Summary of Regression Analysis Using Confidence in One's Own Ability to Work with Statistics, at the Beginning of the Course, as Dependent Variable.

The amount of variance in **confidence in one's own ability to work with statistics, at the end of the course,** accounted for by the a) total expectations of success, b) trait anxiety, c) level of the subject, d) subjective perception of previous mathematical ability, e) teacher competence, f) number of years of high school mathematics, g) intrinsic motivation, h) feedback, i) evaluation, j) spatial ability, was .39 (Tabel 8).

Variables	Multiple R	R^2	F	Signif.
Total Expectations	.4360	.1901	181.938	.000
Trait Anxiety	.5111	.2612	136.804	.000
Level of the Subject	.5612	.3150	118.466	.000
Subjective Background	.5779	.3339	96.759	.000
Teacher Competence	.5927	.3513	83.513	.000
Objective Background	.6039	.3647	73.664	.000
Intrinsic Motivation	.6146	.3777	66.676	.000
Feedback	.6197	.3840	59.840	.000
Evaluation	.6231	.3883	54.092	.000
Spatial Ability	.6263	.3922	49.434	.000

Table 8. Summary of Regression Analysis Using Confidence in the One's Own Ability to Work with Statistics, at the End of the Course, as Dependent Variable.

Discussion

The study of the different multiple regression analyses shows several findings:

1. The independent variables utilized are not useful to predict three of the factors selected to measure attitudes toward statistics:

   a. Enjoyment: The R^2 in the pretest was .21 and .27 in the postest.
   b. Motivation: The R^2 in the pretest was .11 and .22 in the postest.
   c. Usefulness: The R^2 in the pretest was .11 and .16 in the postest.

2. Regarding the factors related to **general attitudes toward statistics**:

   a. The principal factors predicting attitudes toward statistics **at the beginning of the course** are:

      - Expectations of Success and Failure in the course
      - Attitudes toward Computers and Usefulness of Computers
      - Intrinsic Motivation and Motivation toward the Major
      - Objective and Subjective Background
      - State Anxiety
      - Sex. The one-way ANOVA run on this variable showed that males have a significantly higher mean in attitudes toward statistics than females at the beginnig of the course ($F=13.267$, $p<.001$).

   b. The principal factors predicting attitudes toward statistics **at the end of the course** are:

      - Expectations of Success or Failure
      - Intrinsic Motivation
      - Subjective and Objective Background
      - Level of the Subject
      - Teacher and Course Evaluation

   c. Spatial Ability, Sex Role, Extrinsic Motivation and Trait Anxiety do not significantly contribute to the prediction of general attitudes toward statistics neither in the pretest nor in the postest.

3. Regarding the factors related to **anxiety toward statistics**:

a. The principal factors predicting anxiety toward statistics **at the beginning of the course** are:

- Expectations of Success and Failure in the course
- Anxiety, Enjoyment and Confidence in Computers
- Motivation toward the Major
- Objective and Subjective Background
- State and Trait Anxiety

b. The principal factors predicting anxiety toward statistics **at the end of the course** are:

- Expectations of Success or Failure
- Subjective and Objective Background
- Level of the Subject
- Teacher and Course Evaluation
- State Anxiety
- Number of Students in the class

c. Spatial Ability, Sex and Sex Role, and Extrinsic and Intrinsic Motivation do not significantly contribute to the prediction of anxiety toward statistics neither in the pretest nor in the postest.

4. Regarding the factors related to **confidence in one's own ability to work with statistics**:

a. The principal factors predicting confidence in statistics **at the beginning of the course** are:

- Expectations of Success and Failure in the course
- Anxiety, Enjoyment and Confidence in Computers
- Extrinsic Motivation and Total Motivation
- Objective and Subjective Background
- State and Trait Anxiety

b. The principal factors predicting confidence in statistics **at the end of the course** are:

- Expectations of Success and Failure
- Subjective and Objective Background
- Level of the Subject
- Teacher and Course Evaluation
- Trait Anxiety
- Intrinsic Motivation
- Spatial Ability

c. Sex and Sex Role, Motivation toward the Career, and Usefulness of the Computers do not significantly contribute to the prediction of confidence in one's own ability in statistics neither in the pretest nor in the postest.

In summary, attitudes toward statistics seem to be a multifactorial construct. Different variables can be used to predict different dimensions of this general construct. However, some variables appear in all the models. They are the following:

a. To predict attitudes at the beginning of the course:

- Expectations of Success and Failure
- Attitudes toward Computers
- Objective and Subjective Background
- Motivation
- State Anxiety

b. To predict attitudes at the end of the course:

- Expectations of Success and Failure
- Subjective and Objective Background
- Level of the Subject
- Teacher and Course Evaluation

These results suggest that the students' expectations toward the subject is an important variable to predict their attitudes. This variable is independent of aptitude. Students with a common aptitude level may well have different attitudes or achievement

levels that are tied to different expectations for success in the subject matter. Therefore, it is important to introduce some variations in instructional strategies. If students with low expectations are going to develop negative attitudes toward statistics, the most profitable strategy would be first to build confidence and subsequent higher expectation levels in the low expectation students.

Another suggestion from these data is to require a higher previous mathematical background for these students. The assumption that the difficulties encountered by many of these students may be attibuted to inadequate mathematical training was confirmed.

The results here also suggest the importance of teachers in determing students' attitudes toward statistics. Teachers can improve or decrease the confidence, anxiety, and expectations of their students.

Attitude toward computers seems to be an important variable in predicting attitudes toward statistics. If we want to include computers in statistics instruction, it is important to develop positive attitudes toward its use. It will affect not only the computer instruction but the statistics instruction as well.

Other variables like spatial ability or sex-role do not seem to be important in predicting attitudes toward statistics. Maybe they are more important as predictors of achievement in this subject.

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ITEMS OF THE MULTIFACTORIAL SCALE OF ATTITUDES TOWARD STATISTICS

1. Statistics is a very worthwhile and necessary subject.
2. I'm not the type to do well with statistics.
3. Statistics doesn't scare me at all.
4. Statistics is enjoyable to me.
5. Statistics is too theoretical to be of much practical use to the average professional.
6. I want to develop my statistical skills.
7. Statistics is one of my most dreaded subject.
8. I have a lot of self-confidence when it comes to statistics.
9. I enjoy talking with others about statistics.
10. Statistics may be useful to someone who plans to pursue a career in research, but not very useful to the average professional.
11. Knowing how to work with statistics will increase my job possibilities.
12. My mind goes blank and I am unable to think clearly when working with statistics.
13. I am very calm and unafraid when studying statistics.
14. Statistics is enjoyable and stimulating to me.
15. I expect to have little use for statistics in my professional life.
16. Other subjects are more important to my career than statistics.
17. Studying statistics makes me feel very nervous.
18. I don't get upset when trying to work statistics problems.
19. I would like working with statistics.
20. I get a great deal of satisfaction out of solving a statistics problem.
21. Statistics is one of the most important subjects to my professional life.
22. Statistics makes me feel uncomfortable and nervous.
23. I'm sure I would able to learn statistics.
24. Given the opportunity, I would take another statistics course even though it wasn't required.
25. Statistics is not a very interesting subject.